CAREER: New Materials in Condensed Matter Physics: The Case of Quasicrystals

Ian Fisher, Stanford University, DMR-0134613

- Our lab concentrates on the development of new materials, focusing on those with exotic magnetic and electronic properties.
- One area of current interest is quasicrystals. These materials exhibit long-range atomic order but without the translational symmetry of conventional crystals. Key questions include: how does this kind of atomic order affect the magnetic and electronic properties of a solid, and what is the influence of the degree of structural perfection?
- To experimentally address the above questions requires the growth of single quasicrystal samples. Fig. 1 shows results for a new phase that we have recently been able to synthesize in single grain form.
- Results for this material and others like it help us to understand the key differences between periodic and non-periodic ordered solids.
- In the realm of crystalline materials, this award also funds research in electronic transport in materials with large unit cells, and magnetism of complex oxides. Recent results for the singlet compound $Sr_2Cu(BO_3)_2$ are shown in Fig. 2.

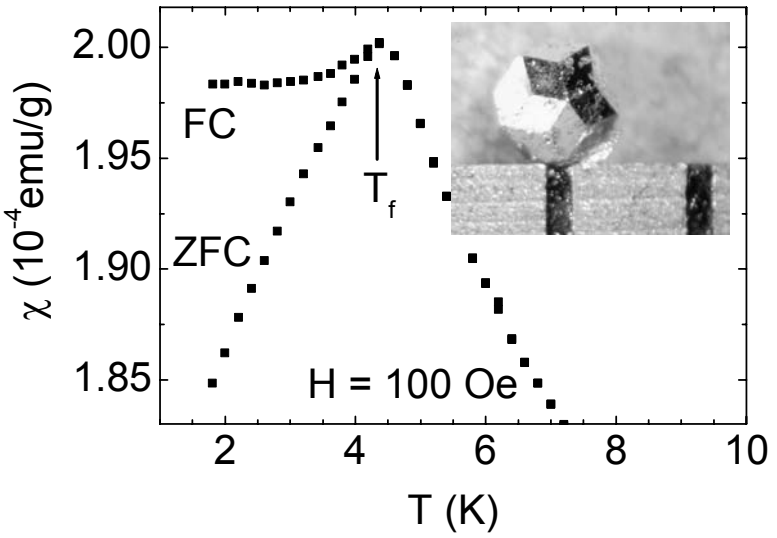

Fig. 1. Magnetic behavior of single quasicrystal of Gd-Mg-Cd. Arrow marks the spin-freezing temperature, below which the material is in a spin glass state. Inset shows a photograph of a representative single-quasicrystal over a mm scale. The sample has an unusual rhombic-triacontahedral morphology: note the axis of 5-fold rotational symmetry which is forbidden in periodic crystal structures. These are the first single-grain samples of this material, which allows a detailed investigation of their thermodynamic and transport properties.

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Brief summary of outreach activities:

- Participation, including graduate students from our group, in the QUEST program – providing research experience for financially challenged and under-represented students.
- Extensive undergraduate involvement in laboratory research.
- Continued involvement in undergraduate dorm events, elevating awareness of the role that materials research plays in both fundamental physics and technological applications through talks and discussions.

Educational activities:

- 2 undergraduates funded by this award
- 2 students supported by an REU supplement
- 1 grad student funded by this award
- Teach 3 lecture courses
  (a) How Things Work
  (b) Introductory Solid State Physics
  (c) Magnetism & Long Range Order in Solids

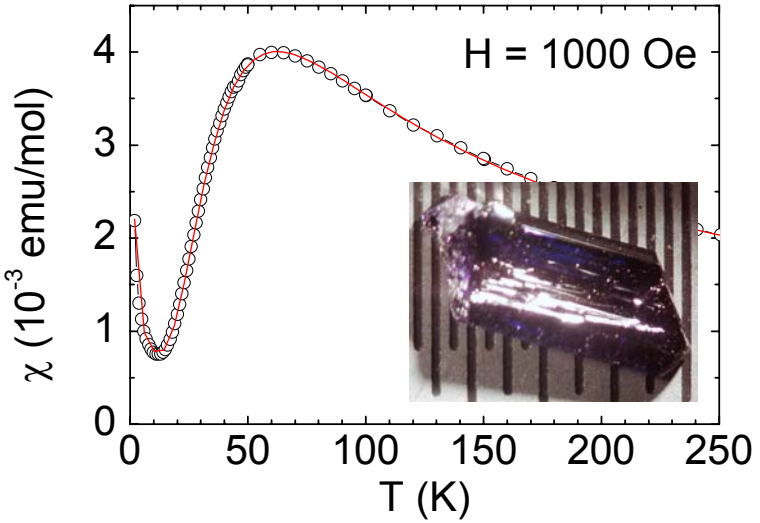

Fig. 2. Susceptibility data for single-crystal $Sr_2Cu(BO_3)_2$. These are the first single crystals of this material. Line shows fit to isolated dimer model with a spin gap of 100 K. Inset shows photograph of a typical single crystal sample.

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